

Rome

Technology + Engineering



CONCRETE

Content adapted from: <http://www.businessweek.com/articles/2013-06-14/ancient-roman-concrete-is-about-to-revolutionize-modern-architecture> and <http://www.history.com/news/history-lists/10-innovations-that-built-ancient-rome>



Above: A researcher collecting a Roman concrete sample near Naples, Italy.

What is the key ingredient to these Roman structures?

The key ingredient is concrete. Maybe concrete does not seem that impressive or exciting to you, but can you imagine what our world would be like without it? Today, concrete is the most widely used engineering material in the world (19 billions tons per year!). Partly, this is because it is so cheap as compared to steel or other materials, but concrete is also durable and able to be formed into all kinds of shapes and sizes. The Romans were the first to develop concrete. Their recipe was different from the concrete we use today, but it was definitely durable—many of the impressive buildings, aqueducts and roads Romans built are still standing today.

Could the Romans help us build more durable structures AND help the environment?

Just recently we figured out what makes Roman concrete so durable, especially in seawater, and it took a team of international researchers to do it! These researchers studied the Roman harbor, which is over 2000 years old and is perfectly intact. This is especially impressive because the concrete we use today starts to erode after only 50 years in seawater. Scientists not only discovered that lime (mineral, not fruit) and volcanic ash seem to be key in making Roman concrete so stable, but that the Roman's process was also much better for the environment than the one we use. Currently, cement production accounts for 7% of the carbon dioxide that industry puts in the air. Carbon dioxide is a leading contributor to climate change. The next challenge is for researchers to figure out how we can incorporate some of the Roman techniques and materials into modern concrete production—this would revolutionize the building industry.

ROADS & VIADUCTS

All Roads Lead to Rome

Again, roads may not seem like all that impressive of a development to us today because we take them for granted. Think about how our lives would be different without a system of usable roads in place.

The Romans put a lot of time and energy into building a system of roads across their entire empire, (which covered 1.7 million square miles at its height). These roads were well-designed and followed strict standards to allow for drainage and durability (they are still used today!). The Roman military built the 50,000 miles of roads by hand using dirt, gravel and strong bricks. At the time, this was the most sophisticated network of roads on the planet. In fact, there was a saying that “All roads lead to Rome” because it was possible for one to travel from one end of the empire to Rome without ever leaving a Roman road.

The Romans built the roads mostly for military purposes. Roman roads allowed their military to travel great



distances in a short period of time, which was particularly important in managing “trouble-spots” or insurrections against the empire and conquering new territories. However, the roads also efficiently allowed people, goods, and ideas to travel across

the empire and to various ports. For the first time in history it was possible to send a letter a long distance in just a few days.

WHERE AM I? The Romans put milestone markers on the

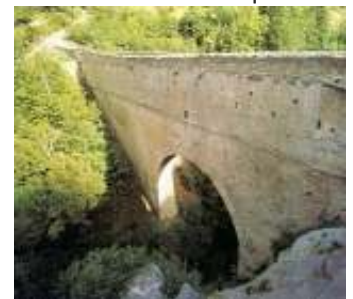
The Romans built a network of roads across their entire empire.



side of the roads to let travellers know how far they were from various destinations (the photo on the right is an example). Some of these milestones also included a place for horses (and humans) to drink water like a sort of rest stop.



VIADUCTS Another important aspect of the Roman road network was the viaducts they built. Viaducts are basically bridges that allow people and vehicles to travel over valleys, water or even another road. Roman viaducts were built with a series of arches of equal length and definitely stood the test of time as many still are standing today, as the one pictured here (this one is also an aqueduct, which you will learn about on the next page).



Today, we still construct viaducts (those “bridges” you drive under while on the expressway are viaducts, for example). In fact, some American viaducts like the one pictured here look awfully Roman.



The Nicholson Viaduct, Pennsylvania

AQUEDUCTS, CIVIL ENGINEERING + PUBLIC HEALTH

AQUEDUCTS: WHAT'S THE BIG DEAL?

By about 312 BCE the Romans took that concrete they came up with and put it to good use---they figured out how to engineer large-scale aqueducts built from stone or concrete and powered by gravity. This was quite a civil engineering project. Civil engineering is the design, construction and maintenance of public goods like roads, dams, and bridges. Aqueducts allowed Romans to efficiently transport water from far away (sometimes 60 miles) into city centers, which had a big impact. Aqueducts essentially brought running water to cities and supplied water to public bathhouses, private homes, fountains, and latrines (the first public bathroom!). The Romans also constructed public sewage systems to take the human waste away---an important development in promoting public health!



Left: The remains of a Roman public restroom.

http://en.wikipedia.org/wiki/File:Housesteads_latrines.jpg

ROMAN SEWAGE SYSTEM

In larger Roman towns, people often got sick or died from drinking water that had been contaminated with sewage. Sewage is human waste -- what we flush down the toilet. When people drink water with human waste in it, they can get other people's germs and get sick with dysentery or die. To fix this problem, many Roman towns built aqueducts to bring in fresh water from the hills outside of the towns. They also built public latrines and systems of sewage pipes to carry sewage



A Roman aqueduct that is still standing!
lillisphotography/iStockphoto.com

out of the streets and dump it into the river. This was a big improvement on Greek sewage arrangements, where people just poured their waste into the street however they wanted.

Roman sewers just dumped raw sewage into the river, which was better than leaving it lying around in the streets, but still did spread germs sometimes. The Romans didn't have any way of treating sewage to kill the germs, as we do today, and they didn't understand the need to do that.

Some of these sewers are still being used today.

In smaller towns, though - most of the towns in the Roman Empire - there weren't any sewers, and sewage collectors came through and got the waste (human waste!) from each house and carried it off to sell to farmers to use as fertilizer on their fields, just like in ancient China at the same time. In small villages (where most people lived), they didn't even have outhouses, and people just walked out to the fields every morning and relieved themselves there.

CENTRAL HEATING + THERMAL BATHS

Central Heating

In the Roman Empire, wealthy people lived in big houses called villas that looked like this one:



www.brimms.co.uk/romans/towns.html

You can imagine that a place like this could get pretty cold in the winter and that it would be hard to keep it evenly heated with just fireplaces. Over time, Romans developed a system to heat their homes that was different from having a fireplace in every room. They developed technology called a **hypocaust** which was able to centrally heat their buildings (today we use furnaces to centrally heat buildings). The hypocaust worked by sending heat through hollow floors and walls from one continuously burning fire (which was kept going by slaves). The heat would warm the floors and walls, and in turn, the rooms. In order for the system to work, Romans had to build their buildings in a special way. For instance, they built brick tunnels under their floors (air ducts). Here is a picture of what it looked like under the floor:



www.pages.drexel.edu/~jpm55/AE390/A5/hypocaust.htm



The Roman Baths

The main use of the hypocaust in the Roman Empire was in Roman bathhouses. The hypocaust heated all the pools, saunas and rooms of the bathhouses.

Bathhouses were places where free people could not only take a bath, but also exercise, socialize, conduct business and show off their fancy jewelry and get pampered. Archaeologists have found interesting evidence that there was a wide range of activity happening in these bathhouses beyond bathing including gambling, medical procedures and dentistry.



Great Bath at the Roman baths, Aquae Sulis (Bath). Source: Andrew Dunn/Wikimedia Commons.